

# PATENT ABSTRACTS OF JAPAN

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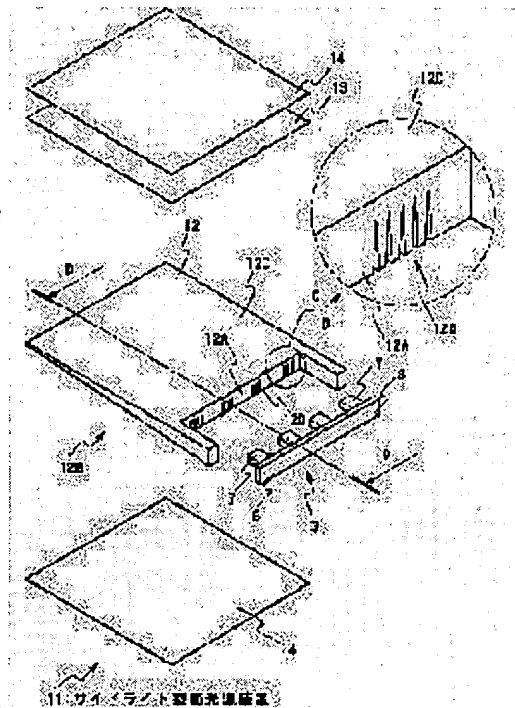
(72)Inventor : ONO TOSHIAKI

## (54) LIGHT GUIDE PLATE, SIDELIGHT SURFACE LIGHT SOURCE DEVICE AND LIQUID-CRYSTAL DISPLAY DEVICE

(57)Abstract:

**PROBLEM TO BE SOLVED:** To reduce brightness irregularity in the vicinity of an incoming surface by preventing luminous points of point light sources from being seen from the outgoing surface side, in the case of a light plate, a sidelight surface light source device, and a liquid-crystal display device, using point light sources as primary light sources, in which, for example, light goes out from local luminous areas with relatively intense directivity.

**SOLUTION:** A plurality of grooves 12D extending in the thickness direction are formed, at least, in portions of a light guide plate 12 confronting point light sources 7, and they are formed so that the cut depths of the grooves 12D are gradually decreased toward an outgoing surface 12C at least in the vicinity of the outgoing surface 12C.



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CLAIMS

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[Claim(s)]

[Claim 1] In the light guide plate which carries out incidence of the illumination light which carried out outgoing radiation from the point light source from an end face, is crooked and carries out outgoing radiation of said illumination light from an outgoing radiation side The light guide plate which forms two or more slots extended in the thickness direction in the part which counters said point light source of said end face at least, and is characterized by forming said slot so that it may carve gradually and the lump depth may become shallow at least as said outgoing radiation side is approached [ near / said / the outgoing radiation side ].

[Claim 2] The light guide plate according to claim 1 or 2 characterized by forming said slot so that it may carve by the said outgoing radiation side and field side which counters and the lump depth may become the deepest.

[Claim 3] Side light mold face light equipment characterized by using a light guide plate according to claim 1 or 2.

[Claim 4] The liquid crystal display characterized by illuminating a liquid crystal display panel with side light mold face light equipment according to claim 3.

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## DETAILED DESCRIPTION

### [Detailed Description of the Invention]

[0001]

[Field of the Invention] this invention -- a light guide plate, side light mold face light equipment, and a liquid crystal display -- being related -- for example, directivity comparatively strong from a local luminescence field -- with, when light comes to make into the primary light source the point light source which carries out outgoing radiation, it can apply. as the point emitting [ of the point light source ] light cannot be viewed from an outgoing radiation side side by [ this slot carves / at least / form two or more slots extended in the thickness direction to the part to which this invention counters the point light source of a light guide plate at least, and / near the outgoing radiation side /, and the lump depth approaches an outgoing radiation side ] it being alike, following and making it become gradually shallow, the brightness nonuniformity near the plane of incidence is reduced.

[0002]

[Description of the Prior Art] The former, for example, a liquid crystal display, is made as [ illuminate / with side light mold face light equipment / a liquid crystal display panel ].

[0003] Drawing 6 is the decomposition perspective view showing an example of the side light mold face light equipment 1 which constituted the primary light source according to the point light source, and drawing 7 is the sectional view cutting off and showing drawing 6 by the A-A line. This side light mold face light equipment 1 arranges the primary light source 3, carries out the laminating of the reflective sheet 4 and the light guide plate 2 to the side of a light guide plate 2 one by one, and is formed in it. In addition, \*\*\*\* arrangement of the various web materials to which side light mold face light equipment 1 amends the property of outgoing radiation light on outgoing radiation side 2C of a light guide plate 2 is carried out if needed.

[0004] directivity with the primary light source 3 comparatively strong from the local luminescence field where the closure of the semiconductor chip was carried out to the resin package of for example, a rectangle configuration -- with, light carries the point light source 7 which carries out outgoing radiation in the attachment components 8, such as a printed circuit board, and is formed, and incidence of the illumination light by which outgoing radiation is carried out from these point light sources 7 is carried out to plane-of-incidence 2A of a light guide plate 2.

[0005] A light guide plate 2 carries out injection molding of the acrylic (PMMA resin) which becomes for example, by the transparence member, is formed in a cross-section wedge-action-die configuration, and carries out incidence of the illumination light of the primary light source 3 from plane-of-incidence 2A. More nearly thereby than rear-face 2B and outgoing radiation side 2C, a light guide plate 2 repeats between reflective sheet 4 side flat-surface (it is called rear face below) 2B and outgoing radiation side 2C, reflects, spreads the illumination light, and carries out outgoing radiation of the component below a critical angle in the case of the reflection in this rear-face 2B and outgoing radiation side 2C.

[0006] The reflective sheet 4 is formed of the scattered reflection member of the shape of a sheet which becomes with a specular reflection member or a white PET film of the shape of a sheet which becomes by a metallic foil etc., and it reflects the illumination light which begins to leak from rear-face 2B of a

light guide plate 2, it is made it to carry out re-incidence to a light guide plate 2, and, thereby, it raises the use effectiveness of the illumination light.

[0007] Crevice 2D is formed in the part to which a light guide plate 2 counters with the point light source 7 in the side light mold face light equipment 1 concerning the outgoing radiation principle of such illumination light.

[0008] That is, in side light mold face light equipment 1, when plane-of-incidence 2A of a light guide plate 2 is created according to a flat field, in the plane-of-incidence side corner of outgoing radiation side 2C, the outgoing radiation quantity of light falls between the point light sources 7 near the plane of incidence, and, thereby, brightness nonuniformity occurs near the plane of incidence with the directivity of the illumination light by which outgoing radiation is carried out from the point light source 7, so that Sign E may show.

[0009] As it expands partially with Sign B and drawing 6 is shown, crevice 2D is formed in the thickness direction of a light guide plate 2 at an almost uniform cross-section approximate circle arc configuration, and the curved surface of this radii configuration functions as a lens side of a concave lens. Thereby, a light guide plate 2 amends the directivity of the illumination light L by which concentrates and outgoing radiation is carried out in the direction of a transverse plane of the point light source 7 into a field parallel to outgoing radiation side 2C, and distributes the illumination light to the corner of outgoing radiation side 2C between the point light sources 7.

[0010] Thereby in the side light mold face light equipment 1 by this kind of point light source, it is made as [ reduce / the brightness nonuniformity near the plane of incidence ].

[0011]

[Problem(s) to be Solved by the Invention] By the way, in side light mold face light equipment 1, when crevice 2D is formed in the point light source 7 and the part which counters in this way, as Sign C shows drawing 7, direct outgoing radiation of the illumination light by which outgoing radiation is carried out from the point light source 7 through this crevice 2D will be carried out to the outgoing radiation side 2C side.

[0012] Thereby, even if it can prevent brightness nonuniformity in a liquid crystal display, the point of the point light source emitting light is viewed from an outgoing radiation side side, and there is a problem on which the grace of the display screen deteriorates remarkably.

[0013] This invention was made in consideration of the above point, and tends to propose the light guide plate which can reduce the brightness nonuniformity near the plane of incidence as cannot view the point of the point light source emitting light from an outgoing radiation side side, the side light mold face light equipment using this light guide plate, and a liquid crystal display.

[0014]

[Means for Solving the Problem] In invention which relates to claim 1 in order to solve this technical problem In the light guide plate which carries out incidence of the illumination light which carried out outgoing radiation from the point light source from an end face, is crooked and carries out outgoing radiation of the illumination light from an outgoing radiation side Two or more slots extended in the thickness direction are formed in the part which counters the point light source of an end face at least, and at least, this slot is formed so that it may carve gradually and the lump depth may become shallow, as an outgoing radiation side is approached [ near the outgoing radiation side ].

[0015] Moreover, in invention concerning claim 2, a slot is formed so that it may carve by the outgoing radiation side and field side which counters and the lump depth may become the deepest.

[0016] Moreover, in invention concerning claim 3, side light mold face light equipment is constituted using a light guide plate according to claim 1 or 2.

[0017] Moreover, in invention concerning claim 4, a liquid crystal display panel is illuminated with side light mold face light equipment according to claim 3, and a liquid crystal display is formed.

[0018] In the light guide plate which according to the configuration concerning claim 1 carries out incidence of the illumination light which carried out outgoing radiation from the point light source from an end face, is crooked and carries out outgoing radiation of the illumination light from an outgoing radiation side Form two or more slots extended in the thickness direction in the part which counters the

point light source of an end face at least, and it sets near the outgoing radiation side at least. The direct outgoing radiation by the side of the outgoing radiation side of the illumination light by which reduced the brightness nonuniformity near the outgoing radiation side by two or more slots by forming a slot so that it might curve gradually and the lump depth might become shallow as the outgoing radiation side was approached, and outgoing radiation was carried out from the point emitting light can be prevented. [0019] Moreover, according to the configuration concerning claim 2, by forming a slot so that it may curve by the outgoing radiation side and field side which counters and the lump depth may become the deepest, with a simple configuration, as the point of the point light source emitting light cannot be viewed from an outgoing radiation side side, the brightness nonuniformity near the outgoing radiation side can be reduced.

[0020] Moreover, according to the configuration concerning claim 3, surface light source equipment can be constituted also near the plane of incidence by constituting side light mold face light equipment using a light guide plate according to claim 1 or 2, using an outgoing radiation side effectively.

[0021] Moreover, according to the configuration concerning claim 4, a liquid crystal display panel is illuminated with side light mold face light equipment according to claim 3, if a liquid crystal display is formed, a liquid crystal display can be constituted also near the plane of incidence of surface light source equipment, using an outgoing radiation side effectively, and a high-definition display image can be displayed.

[0022]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained in full detail, referring to a drawing suitably.

[0023] (1) The block diagram 1 of the gestalt of operation is a decomposition perspective view showing the side light mold face light equipment applied to the gestalt of operation of this invention. In the liquid crystal display concerning the gestalt of this operation, a liquid crystal display panel is illuminated with this side light mold face light equipment 11. In addition, in the configuration shown in this drawing 1, the same configuration as the side light mold face light equipment 1 mentioned above about drawing 6 attaches a corresponding sign, it is shown and the duplicate explanation is omitted.

[0024] In this side light mold face light equipment 11, the reflective sheet 4 is arranged to the rear-face 12B side of a light guide plate 12, and further, on outgoing radiation side 12C, the laminating of the prism sheets 13 and 14 is carried out, and it is formed.

[0025] More here than plane-of-incidence 12A, a light guide plate 12 carries out injection molding of the acrylic (PMMA resin) which becomes by the transparence member, is formed in a cross-section wedge-action-die configuration, and carries out incidence of the illumination light of the primary light source 3. More nearly thereby than rear-face 12B and outgoing radiation side 12C, a light guide plate 12 repeats between rear-face 12B and outgoing radiation side 12C, reflects, spreads the illumination light, and carries out outgoing radiation of the component below a critical angle in the case of the reflection in this rear-face 12B and outgoing radiation side 12C.

[0026] Furthermore, the light-scattering pattern to which this light guide plate 12 makes rear-face 12B a split face locally, and the outgoing radiation of the illumination light is urged is formed. Of suitable split-face-ized processing of a processing processing, an electron discharge method, etc. by etching to the metal mold which mat-side-processes and corresponds, for example, a light-scattering pattern split-face-izes an outgoing radiation side in a circular configuration partially, and is formed here. Moreover, a light-scattering pattern is seen from an outgoing radiation side side, and is formed of the minor diameter where consciousness is difficult.

[0027] In the part to which the outgoing radiation quantity of light falls when rear-face 12B is formed according to a mirror plane, these light-scattering pattern is formed so that it may correspond to the fall of this quantity of light, and the number per unit area may increase, and it is made as [ equalize / the outgoing radiation quantity of light of the illumination light by which outgoing radiation is carried out by this than outgoing radiation side 12C ]. In addition, in the gestalt of this operation, a light-scattering pattern is irregularly arranged about the direction which met plane-of-incidence 12A near the plane-of-incidence 12A further, so that the number per unit area may increase gradually toward the corner of

outgoing radiation side 12C between the point light sources 7, so that the number per unit area may increase gradually toward a wedge-action-die tip from the plane-of-incidence 12A side. In addition, light-scattering patterns may be other configurations, such as not only a circular configuration but a rectangle configuration. Moreover, also by changing extent of granularity and split-face-izing the whole surface of rear-face 12B, the outgoing radiation quantity of light of the illumination light by which outgoing radiation is carried out from outgoing radiation side 12C can also be equalized.

[0028] Thus, the light guide plate 12 which carries out outgoing radiation of the illumination light is made as [ form / slot 12D of the same configuration / in plane-of-incidence 12A / repeatedly ] so that it may expand partially with an arrow head C and may be shown. Such slot 12D is formed in the point light source 7 and the part which counters here so that it may extend in the thickness direction of plane-of-incidence 12A.

[0029] Furthermore, slot 12D connects the slant face by one pair of flat surfaces to which it inclined aslant to plane-of-incidence 12A as a cross section was taken according to a field parallel to outgoing radiation side 12C and it was shown in drawing 2, and is formed, and thereby, a light guide plate 12 amends the directivity of the illumination light L by which concentrates in the direction of a transverse plane of the point light source 7, and outgoing radiation is carried out, and it carries out incidence of the illumination light so that it may spread about this field inboard.

[0030] Furthermore, it carves gradually and the lump depth becomes shallow as outgoing radiation side 12C is approached from rear-face 12B, and slot 12D is formed so that it may stop near outgoing radiation side 12C. In the gestalt of this operation, slot 12D is formed here so that it may carve in monotone and the lump depth may fall, as outgoing radiation side 12C is approached. As drawing 1 is cut off by D-D line by this and it is shown in drawing 3, a light guide plate 12 interrupts the illumination light by which outgoing radiation is carried out from the point light source 7 towards the outgoing radiation side 12C side by plane-of-incidence 12A, and the point of the point light source 7 which is the point light source emitting light is made not to be viewed from the outgoing radiation side 12C side.

[0031] As for the prism sheet 13, the prism side which is an optical controlling surface is formed in the field by the side of reverse, as for outgoing radiation side 12C of a light guide plate 12. From the plane-of-incidence 12A side, the projection by one pair of slant faces which extend a prism side almost in parallel with plane-of-incidence 12A of a light guide plate 12 is repeated toward a wedge-action-die tip, is formed, and amends the directivity of the illumination light by which outgoing radiation is carried out from a light guide plate 12 in one pair of these slant faces in the direction of a transverse plane of outgoing radiation side 12C here.

[0032] With outgoing radiation side 12C of a light guide plate 12, the continuing prism sheet 14 is repeatedly formed in the field by the side of reverse so that the same projection as the prism sheet 13 may extend in the extended direction of a projection of the prism sheet 13, and the direction which intersects perpendicularly mostly. Thereby, the prism sheet 14 emphasizes and injects the directivity of the illumination light by which outgoing radiation is carried out in the direction of a transverse plane of outgoing radiation side 12C from the prism sheet 13.

[0033] (2) In the configuration beyond actuation of the gestalt of operation, the illumination light injected from the point light source 7 spreads the interior of a light guide plate 12, while incidence is carried out to the interior of a light guide plate 12 and this illumination light repeats reflection between rear-face 12B and outgoing radiation side 12C from ( drawing 1 ) and plane-of-incidence 12A. At this time [ C / outgoing radiation side 12 ], whenever it reflects this illumination light by rear-face 12B, the incident angle over outgoing radiation side 12C falls, and outgoing radiation of the component which carries out incidence below by the critical angle to outgoing radiation side 12C is carried out. Moreover, in case it reflects by rear-face 12B, illumination light is scattered about with the optical diffusion pattern formed in this rear-face 12B, and when rear-face 12B is created according to a flat field as a result, it is urged to outgoing radiation in the part into which the outgoing radiation quantity of light decreases, and outgoing radiation is carried out by almost uniform quantity of light distribution from outgoing radiation side 12C.

[0034] Thus, in carrying out incidence of the illumination light to a light guide plate 12 from the point light source 7, when outgoing radiation of the illumination light by which outgoing radiation is carried out from the point light source 7 is carried out by sharp directivity towards ( drawing 2 ) and the direction of a transverse plane of the point light source 7, by having created the part plane-of-incidence 12A according to the flat field, the outgoing radiation quantity of light falls in the plane-of-incidence side corner of outgoing radiation side 12C between the point light sources 7 near the plane-of-incidence 12A, and brightness nonuniformity is observed.

[0035] On the other hand, in the gestalt of this operation, in slot 12D formed in plane-of-incidence 12A, an optical path is bent by the slant face, respectively and the illumination light L which carries out incidence to the slant face which forms this slot 12D can distribute to the both-sides side of a light guide plate 12 ( drawing 2 ). Thereby, with a light guide plate 12, between the point light sources 7, the quantity of light of the illumination light L which runs short in a plane-of-incidence side corner is compensated, and the brightness nonuniformity of outgoing radiation light is reduced.

[0036] The illumination light which carries out outgoing radiation from the point light source 7 when slot 12D carved gradually as ( drawing 3 ) outgoing radiation side 12C was approached with the light guide plate 12 in having done still in this way and distributing the illumination light L, the lump depth became shallow and slot 12D has stopped near outgoing radiation side 12C, and goes to the outgoing radiation side 12C side is interrupted by plane-of-incidence 12A. It can avoid viewing the point of the point light source emitting light from an outgoing radiation side side by this, and a high-definition display image can be formed as the part liquid crystal display.

[0037] (3) According to the configuration beyond the effectiveness of the gestalt of operation, to the part which counters the point light source 7 of a light guide plate 12 at least Form two or more slot 12D extended in the thickness direction, and it sets near outgoing radiation side 12C at least. by [ this slot 12D carves and the lump depth approaches outgoing radiation side 12C ] it being alike, and following and making it become shallow gradually, as the point of the point light source 7 emitting light cannot be viewed from the outgoing radiation side 12C side, the brightness nonuniformity near the plane-of-incidence 12A can be reduced.

[0038] Therefore, in side light mold face light equipment 11, it can use for the lighting of a liquid crystal display panel etc., without devising processing of protection from light etc. to the outgoing radiation side of a light guide plate in any way near the plane-of-incidence 12A, and an outgoing radiation side can be effectively used also near [ the ] the part plane of incidence. Moreover, as a liquid crystal display, a liquid crystal display can be constituted also near the plane of incidence of surface light source equipment, using an outgoing radiation side effectively, and a high-definition display image can be displayed.

[0039] (4) Although the case approaching outgoing radiation side 12C where it was alike, therefore carved in monotone, and the lump depth was made shallow was described in the gestalt of other operations, in addition the gestalt of above-mentioned operation When carving functionally the 2nd order and making the lump depth shallow as are shown not only in this but in drawing 4 , and this invention approaches an outgoing radiation side, it can be carved gradually, can make the lump depth shallow, and can acquire the same effectiveness as the gestalt of above-mentioned operation as it approaches an outgoing radiation side in short.

[0040] Moreover, although the case where a slot was formed was described so that it might carve most by the rear-face side and the lump depth might become deep in the gestalt of above-mentioned operation As shown not only in this but in drawing 5 , in short, this invention is set near the outgoing radiation side at least, when [ of plane-of-incidence 12A ] forming so that the depth of flute may become the deepest in the center mostly. A slot can be formed and the same effectiveness as the gestalt of above-mentioned operation can be acquired so that it may carve gradually and the lump depth may become shallow, as an outgoing radiation side is approached.

[0041] Moreover, in the gestalt of above-mentioned operation, although the case where a slot was formed only about the point light source and the part which counters was described, as long as this invention forms a slot not only in this but in the point light source and the part which counters, it can

acquire the same effectiveness as the gestalt of above-mentioned operation, for example, in short, may form a slot all over plane of incidence at least.

[0042] Moreover, in the gestalt of above-mentioned operation, although the case where connected the slant face by one pair of flat surfaces to which it inclined aslant to plane-of-incidence 12A, and a slot was formed was described, this invention may form a slot not only according to this but according to a curved surface. In addition, not only when transposing the slant face of the slot which only starts the gestalt of above-mentioned operation in forming a slot according to a curved surface to a curved surface, but when forming so that the cross section of plane of incidence may change with sinusoidal configurations when a cross section is taken according to a field parallel to an outgoing radiation side and it sees for example, it thinks.

[0043] Moreover, in the gestalt of above-mentioned operation, although the case where a slot was only formed in plane of incidence was described, this invention is good also considering the plane of incidence which formed the slot by split-face-ized processing not only by this but for example, mat side processing, adhesion of ink, etc. as the optical diffusing surface. If it does in this way, the illumination light can be efficiently distributed to a both-sides side further much more.

[0044] Furthermore, although the case where the point light source by which the closure of the semiconductor chip was carried out to the resin package of a rectangle configuration in the gestalt of above-mentioned operation was used was described, this invention can be widely applied, when using the point light source of not only this but various configurations. In addition, as these point light sources, without closing in a resin package, there are some which are constituted by mounting a semiconductor chip in a direct substrate front face, and a semiconductor chip may be covered with a protective coating etc. if needed in this case.

[0045] Furthermore, with the gestalt of above-mentioned operation, although the case where incidence of the illumination light was carried out from an end side was described, this invention is widely applicable not only to this but the side light mold face light equipment of a configuration of carrying out incidence of the illumination light from other end faces collectively.

[0046] Furthermore, with the gestalt of above-mentioned operation, although the case where this invention was applied to the side light mold face light equipment using the light guide plate which becomes by the plate-like part material of a cross-section wedge-action-die configuration was described, this invention is widely applicable not only to this but the side light mold face light equipment which used the light guide plate of a monotonous configuration.

[0047] Moreover, although the gestalt of above-mentioned operation described the case where carried out the laminating of the prism sheet to the outgoing radiation side of a light guide plate, and it was arranged to it, if this invention can especially be applied widely and does not have the need when arranging the optical diffusion sheet which diffuses not only this but the illumination light, and arranging various web materials, these web materials are also omissible.

[0048] Furthermore, with the gestalt of above-mentioned operation, although the case where this invention was applied to the surface light source equipment of a liquid crystal display was described, this invention is widely applicable to the light guide plate of this side light mold face light equipment at side light mold face light equipment, such as not only this but various lighting devices, a display, etc., and a pan.

[0049]

[Effect of the Invention] as the point emitting [ of the point light source ] light cannot be viewed from an outgoing radiation side side by [ this slot carves / at least / form two or more slots extended in the thickness direction to the part which counters the point light source of a light guide plate at least according to this invention as mentioned above, and / near the outgoing radiation side / , and the lump depth approaches an outgoing radiation side ] it being alike, following and making it become gradually shallow, the brightness nonuniformity near the plane of incidence can be reduced.

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## DESCRIPTION OF DRAWINGS

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### [Brief Description of the Drawings]

[Drawing 1] It is the decomposition perspective view showing the side light mold face light equipment concerning the gestalt of operation of this invention.

[Drawing 2] It is the sectional view with which explanation of actuation of the slot in the light guide plate of drawing 1 is presented.

[Drawing 3] It is the sectional view in which cutting off drawing 1 by D-D line and showing it.

[Drawing 4] It is the sectional view showing the light guide plate applied to the gestalt of other operations by contrast with drawing 3.

[Drawing 5] It is the sectional view showing the light guide plate which formed the slot by contrast with drawing 3 so that it might become the deepest in the central part of plane of incidence.

[Drawing 6] It is the decomposition perspective view showing conventional side light mold face light equipment.

[Drawing 7] It is the sectional view in which cutting off drawing 6 by the A-A line, and showing it.

### [Description of Notations]

1 11 [ .. A rear face, 2C, 12C / .. An outgoing radiation side, 3 / .. The primary light source, 4 / .. A reflective sheet, 7 / .. The point light source, 12D / .. Slot ] .... 2 Side light mold face light equipment, 12 .. A light guide plate, 2A, 12A .. Plane of incidence, 2B, 12B

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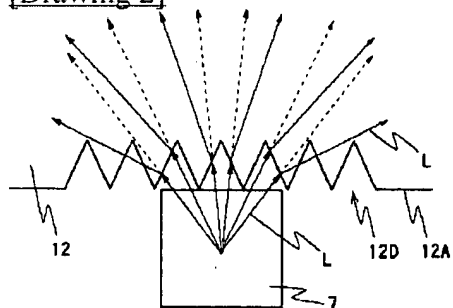
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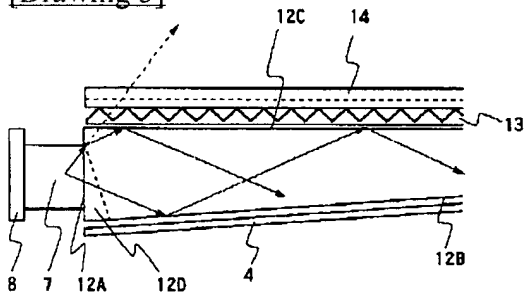
DRAWINGS

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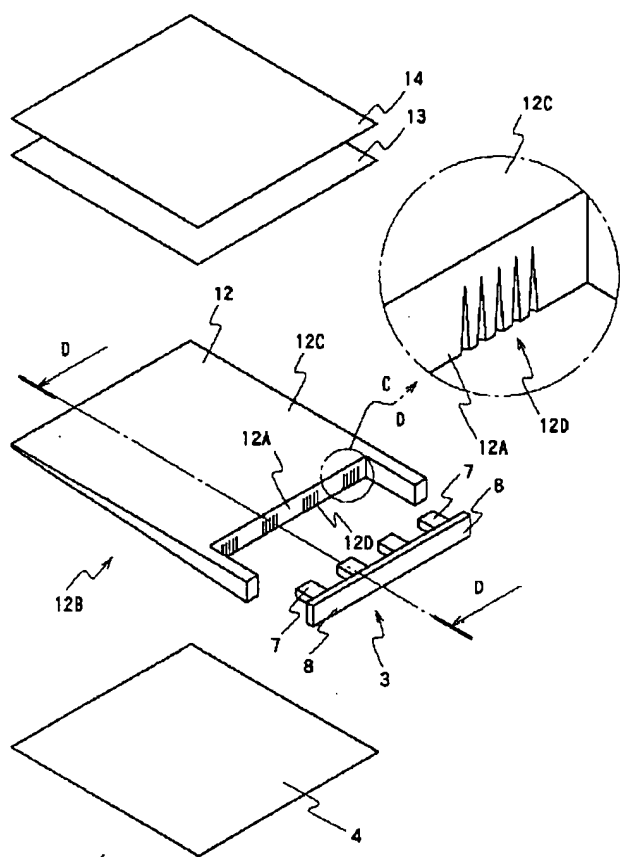
[Drawing 2]



[Drawing 3]

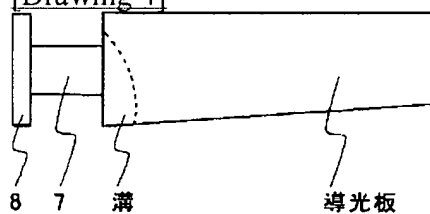


[Drawing 1]

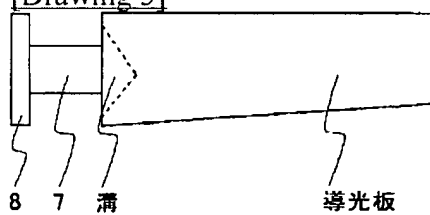


11: サイドライト型面光源装置

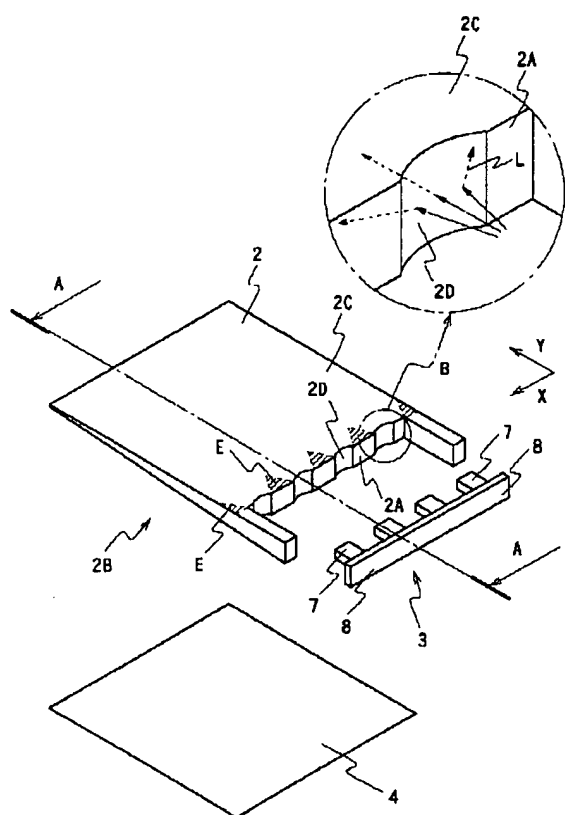
[Drawing 4]



[Drawing 5]

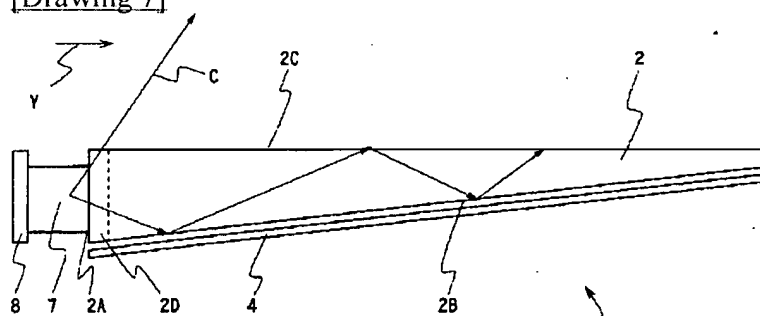


[Drawing 6]



1: サイドライト型面光源装置

[Drawing 7]



### 1: サイドライト型面光源装置

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